PLANT TO PLANT VARIABILITY IN GROWTH AND DEVELOPMENT OF CONVENTIONAL AND TRANSGENIC MAIZE HYBRIDS.

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INTRODUCTION

The introduction of genes in a parental maize line, to obtain single cross hybrids tolerant to biotic stresses, may affect plant-to-plant variability of the obtained transgenic hybrid, because of the potential linkage drag (Tanksley and Nelson, 1996). In this work we have analyzed plant-to-plant variability of different traits of traditional and transgenic single cross maize hybrids (Bt: maize genetically altered to express the bacterial Bt toxin; RR: Rond-up resistant maize, and stacked Bt and RR).

MATERIALS AND METHODS

- The conventional **DK747** maize hybrid and the transgenic versions of this hybrid (**DK747MG[1]**, **DK747RR**, **DK747MGRR**) and the transgenic hybrids **DK190MG[1]**, **DK190RR**, **DK190MGRR** were cultivated at two plant population densities (6 and 12 plants per square meter, **D6** and **D12**, respectively) without nutrients limitations and water restriction. Weeds and insects were adequately controlled. The experiment was repeated during 2008- 2009 (Exp1) and 2009- 2010 (Exp2).

- Individual plant biomass and phonological stages were recorded on 10 plants per plot along the cycle. Plant biomass was estimated using allometric models (Maddonni and Otegui, 2004) until plants were harvested at physiological maturity (PM). Plant growth rates (PGR) were estimated: **PGR_v** (PGR between V_3 and V_6); **PGR_{ps}** (pre- silking PGR, between V_6 and V_{13}); **PGR_s** (around silking PGR; -15 days R_1, R_1, R_1 +15 days). Similarly, ear growth rates (**EGR_s**) were estimated around silking. At PM kernel number per plant (**KNP**) was recorded. Means and coefficients of variation (CV, %) were compared with ANOVA, considering P<0,05 significant differences.

RESULTS

	PGRv (g/ day)		CV PGRv (%)		PGRps (g/ day)		CV PGRps (%)		PGRs (g/ day)		CV PGRs (%)	
	D6	D12	D6	D12	D6	D12	D6	D12	D6	D12	D6	D12
DK747	0,59 (abcd)	0,36 (e)	22,5 (cd)	24,3 (bcd)	4,44 (cd)	2,35 (g)	18,1 (ab)	20,6 (ab)	8,17 (ab)	4,41 (f)	14,2 (de)	23,5 (abc)
DK747MG	0,62 (abc)	0,45 (cde)	19,4 (d)	21,3 (d)	4,50 (cd)	2,84 (efg)	15,2 (b)	20,3 (ab)	7,58 (cd)	4,42 (f)	14,3 (de)	19,1 (bcd)
DK747RR	0,59 (abcd)	0,38 (e)	26,4 (bcd)	27,5 (bcd)	4,21 (d)	2,42 (fg)	19,9 (ab)	22,9 (a)	8,72 (a)	4,64 (f)	12,6 (e)	19,8 (bcd)
DK747MGRR	0,68 (ab)	0,36 (e)	22,4 (cd)	33,7 (ab)	5,10 (ab)	2,64 (fg)	18,9 (ab)	20,7 (ab)	8,10 (bc)	4,66 (f)	12,6 (e)	25,3 (ab)
DK190MG	0,63 (abc)	0,37 (e)	28,8 (abcd)	37,7 (a)	4,79 (bc)	2,84 (f)	21,4 (a)	22,1 (a)	7,04 (de)	3,67 (g)	16,5 (de)	18,9 (cde)
DK190RR	0,66 (ab)	0,43 (de)	28,2 (abcd)	24,5 (bcd)	5,10 (ab)	2,81 (fg)	18,6 (ab)	19,6 (ab)	6,97 (e)	3,83 (g)	14,9 (de)	16,1 (de)
DK190MGRR	0,74 (a)	0,61 (abcd)	26,8 (bcd)	28,1 (abcd)	5,10 (ab)	2,77 (g)	20,1 (ab)	22,0 (a)	6,94 (e)	4,19 (fg)	17,4 (cde)	18,5 (cde)

Table 1: Mean values and CV of PGR_v, PGR_{ps} and PGR_s. For each column, different letters indicate significant differences among hybrids.

Differences in PGR_{ps} and PGR_s among hybrids were found, mainly at D6. For example, DK747MGRR, DK190MGRR and DK190RR exhibited the highest PGR_{ps}. Around silking, DK747MG exhibited the lowest PGR_s.

	TT anthesis (°Cd)		TT silking (°Cd)		ASI (°Cd)		Partitioning Index	
	D6	D12	D6	D12	D6	D12	D6	D12
DK747	918,76 (ij)	967,34 (def)	931,23 (g)	1001,80 (bc)	12,47 (d)	34,41 (a)	0,305 (def)	0,340 (cde)
DK747MG	933,20 (hi)	969,56 (bcd)	943,57 (fg)	1000,60 (bc)	10,37 (de)	31,02 (ab)	0,269 (f)	0,310 (def)
DK747RR	914,23 (j)	950,92 (fg)	925,43 (g)	975,57 (de)	11,19 (de)	24,64 (bc)	0,287 (ef)	0,364 (bcd)
DK747MGRR	923,91 (ij)	968,71 (cde)	933,18 (g)	990,80 (cd)	9,27 (de)	22,08 (c)	0,319 (def)	0,456 (a)
DK190MG	955,71 (defg)	1001,30 (a)	965,22 (e)	1032,80 (a)	9,52 (de)	31,51 (ab)	0,309 (def)	0,399 (abc)
DK190RR	949,79 (gh)	988,06 (a)	961,47 (ef)	1018,30 (ab)	11,68 (de)	30,27 (ab)	0,340 (cde)	0,459 (a)
DK190MGRR	952,41 (efg)	986,56 (ab)	957,17 (ef)	1011,40 (b)	4,76 (e)	24,89 (bc)	0,343 (bcde)	0,436 (a)

Table 2: Thermal time (TT) to anthesis and silking, the anthesis- silking interval (ASI) and the partitioning index (PI:EGR_s/PGR_s). Different letters indicate significant differences among hybrids.

The DK747MGRR showed a shorter ASI than the other versions of DK747, especially at D12. The DK190MGRR had the same behavior, showing a smaller ASI at both densities. At D12 DK747MGRR, DK190RR and DK190MGRR exhibited the highest PI.

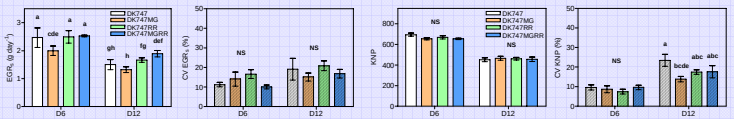


Figure 1: EGRs, KNP and CV of DK747 and the transgenic versions. Different letters indicate significant differences among them.

The DK747MGRR and DK747RR exhibited higher EGR_s than the other hybrids, especially at D12. Despite the higher EGR_s, no differences in kernel number were found among genotypes. The DK747 showed higher CV of KNP at D12.

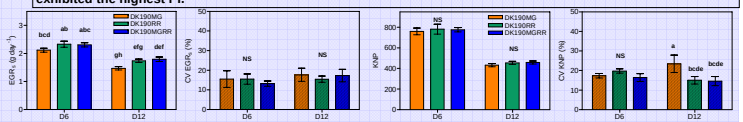
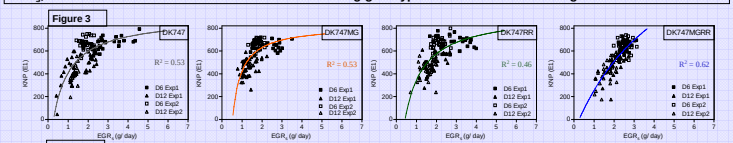


Figure 2: EGR_s, KNP and CV of DK190MG, DK190RR and DK190MGRR. Different letters indicate significant differences among hybrids.

DK190MGRR and DK190RR exhibited higher EGR_s at D12. Despite the higher EGR_s, no differences in KNP were found among genotypes. The DK190MG showed higher CV of KNP at D12.



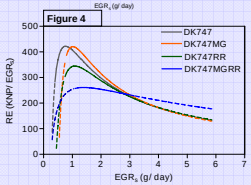
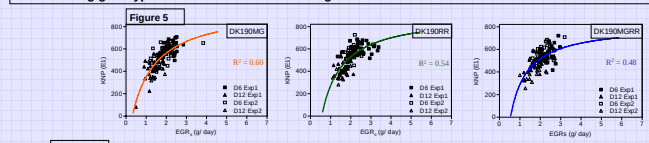


Figure 3 and 4: Figure 3 shows the response of KNP to EGR_s. Lines represent the fitted function to the whole data set (both densities, both experiments), for each genotype. Figure 4 shows the reproductive efficiency (RE) at different EGRs. Curves were obtained from fitted function of Fig. 3. Solid line represents the expected RE values at the explored EGR_s, while dotted line indicates the predicted RE for EGR not explored in our experiments. **Note that DK747RR and DK747MGRR exhibited lower RE values than DK747 and DK747MG at EGR_s within 1 and 3 g day^{-1}.**



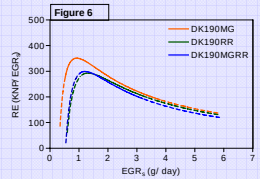


Figure 5 and 6: Figure 5 shows the response of KNP to EGR_s. Lines represent the fitted function to the whole data set (both densities, both experiments), for each genotype. Figure 6 shows the reproductive efficiency (RE) at different EGR_s. Curves were obtained from fitted function of Fig. 5. Solid line represents the expected RE values at the explored EGR_s, while dotted line indicates the predicted RE for EGR not explored in our experiments. **Note that DK190RR and 190MGRR exhibited lower ER values than DK190MG at EGR_s within 1 and 3 g day^{-1}.**

CONCLUDING REMARKS AND FUTURE PROSPECTS

- Differences in plant growth (PGRps, PGRs), ear growth around silking (EGR), and flowering phenology were found among versions of DK747 and DK190.
- Despite of the higher EGRs of DK747MGRR, DK747RR, DK190MGRR and DK190RR, KNP was the same among the different versions, suggesting that the lower reproductive efficiency of the formers canceled the benefits of the higher EGRs to increase KNP.
- Considering that hybrids with the RR or the MGRR events showed a lower RE, we speculate that the RR event itself, or the linkage drag during its introduction in parental lines, reduces the reproductive efficiency of the obtained transgenic hybrids of DK747 and DK190. To understand the underlying processes of the lower RE of these transgenic hybrids, we will study the evolution of flower development and the synchrony of silks emergence of tested hybrids. Moreover, molecular markers will be used to find genetic differences among versions of both hybrids.

LITERATURE CITED

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- Maddonni, G.A. and Otegui, M.E. 2004. Intra-specific competition in maize: early establishment of hierarchies among plant affects final kernel set. Field Crops Res. 85: 1-13.

[1] MG is the trademark of the transgenic Bt hybrid of Monsanto.

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